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AUTHOR Chastain, Garvin; And Others
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ABSTRACT

Levels of independent variable(s) are often mixed within each block of trials rather than each level being presented in a separate block in research of various types. Two experiments involving tasks of a visual nature were conducted to demonstrate that such mixing can easily obscure the effects of principal interest. A target circle was projected parafoveally to the left or right of fixation. The target position was flanked by a nontarget or by no figure. One group of eight subjects received two blocks of trials, with nontarget types mixed within each block, and nontargets appearing to the foveal side of the target position in one block, but to the peripheral side in the other. Analysis of variance indicated a difference in performance between the blocks, with no difference between nontarget types. Another group of eight subjects received nontargets blocked by both position and type, with both variables emerging as significant. The importance of using unmixed designs to determine the effect of different levels of the independent variable(s) was emphasized. (Author)

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Influence of Levels of Independent Variables in Mixed and Unmixed Block Designs

Garvin Chastain, Kevin Martin, Sandra Halvorson, and Roger Bowyer
Boise State University

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The chief concern in laboratory experiments is whether the levels of the independent variable(s) differ in the way they affect performance. To reduce the differential influence of nuisance variables (e.g. practice effects), the levels are often mixed within each block of trials rather than each level being presented in a separate block. In our research on visual perception, we have found that this mixing can easily obscure the very effects which are of principal interest.

A brief series of examples should serve to illustrate the nature of the difficulty. Identification of a parafoveally projected target character is more accurate when the target is flanked by a second nontarget character to its foveal side than when the nontarget is to its peripheral side (Banks, Bachrach, & Larson, 1977). A question arises about whether the physical characteristics of the nontarget are related to the effect. Loomis (1978) flanked parafoveally projected target letters above, below, to the left, and to the right with a set of four black squares in one of three sizes, or a set of four different letters, and compared accuracy of target identification among these conditions. All conditions were mixed over trials, and no marked differences were observed.

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It is somewhat surprising that the physical characteristics of the nontargets were unrelated to the amount of interference they provided in Loomis' (1978) study. The absence of a significant difference was likely due to the mixing of all conditions over trials. We presented a small target circle (with a diameter of .09 deg of visual angle) 1.7 deg to the left or right of fixation in a detection task. The target position was flanked .16 deg toward the fovea or periphery by a solid square of one of three sizes (sides .09 deg, .26 deg, or .43 deg in length), or by no figure. Stimuli were presented to eight subjects in a three channel mirror tachistoscope. Each subject received two blocks of 96 criterion presentations, with nontargets on the foveal side of the target position in one block, and on the peripheral side in the other. Half the subjects received the block with the nontarget on the foveal side first. Nontargets were shown in a random order in each block, with the constraint that each nontarget type appeared four times within each series of 16 trials. Likewise the target appeared on a randomly selected two of these four presentations of each nontarget type. Again, the task involved detecting the target, and the subject spoke the single word "yes" or "no" to indicate the presence or absence of the target. Overall accuracy was stabilized at around 75% during an initial series of practice trials given each subject by manipulating the exposure duration.

As is apparent from Figure 1, the effect of nontarget position was consistent across nontarget types, including the absent nontarget. Although signal detection analysis was not possible with these data due to an occasional variable combination with which performance was perfect, analysis of variance yielded a significant main effect of nontarget position with

the raw data ($F(1,7) = 12.78$, $p < .01$) and data corrected for response bias (Gummerman, 1972) ($F(1,7) = 14.16$, $p < .01$). No significant main effect of nontarget type or interaction between nontarget position and nontarget type appeared with either the corrected or uncorrected data (all $ps > .10$).

Thus with nontarget types mixed within a block, target detection was more accurate in the block in which the nontarget position lay to the foveal side of the target. However, this trend held over all nontarget types, even with the nontarget absent, and was not due to response bias.

We also ran an experiment comparing the effect of nontarget position and nontarget presence or absence for one group receiving conditions mixed over blocks with another receiving conditions presented in separate blocks. Subjects identified a target circle on each exposure as having a gap at the top or bottom, and the target was flanked by a closed circle of the same size on half the exposures, and was exposed alone on the other half. A dollar sign pre- and post-mask was continuously present in the target and nontarget position except when the target was present; as there were only two possible positions to each side of fixation (targets flanked foveally were further from fixation than targets flanked peripherally) the target and nontarget positions were quite apparent. The inner and outer positions were centered 2.14 deg and 2.79 deg from fixation, respectively. For each group of subjects foveally and peripherally flanked targets appeared for 65 msec per exposure in separate blocks. For one group of subjects the target in each position was flanked by a nontarget in one block but not in the other. These subjects thus received four separate blocks of trials. The other group received only two blocks with the target figure appearing on half the presentations chosen randomly within each block.

As is apparent from Table 1, the significant interaction between groups, nontarget position, and presence of the flanking nontarget ($F(1,14) = 11.25$, $p < .01$) indicates that targets in the peripheral position were identified much better than central ones whether the nontarget figure was present or absent when presence and absence were mixed within a block. When targets appeared alone for the entire block, peripheral ones were identified no better than foveal ones. Thus if different nontargets are mixed within a block, they may not appear to provide different amounts of interference no matter what their physical characteristics.

We have observed similar effects by varying target-nontarget separation, and order of appearance of the target and nontarget (simultaneous, target first, or nontarget first). When the levels were mixed within a block, no difference emerged between them. When they were presented in separate blocks, strong differences between levels emerged. This phenomenon is not peculiar to parafoveal asymmetry problems. For example, Johnson and Penney (1966) presented strongly and weakly associated pairs of adjectives in mixed and unmixed lists. In comparison with the unmixed list condition, the use of a mixed list produced slower learning of strongly associated pairs and faster learning of weakly associated pairs. This leveling effect across conditions is similar to that evident in Table 1. Distinctive differences between conditions in unmixed blocks disappeared in mixed blocks, and performance in each condition in mixed blocks was approximately the average of that across conditions in unmixed blocks. Perhaps some higher cognitive factor such as set or expectation (Haber, 1966) is responsible for such leveling. Whatever its source, a methodological implication for using unmixed designs to determine the effect of different levels of the independent variable(s) is clear.

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Table 1

Mean Proportion of Responses Correct for Each Target Position with Mixed vs Unmixed Nontarget Presence and Absence

Nontarget Presence and Absence Mixed Over Trials

	Target Position	
Condition	Inner	Outer
Nontarget Present	.651	.755
Nontarget Absent	.635	.745
Mean	.643	.750

Nontarget Presence and Absence in Separate Blocks

	Target Position	
Condition	Inner	Outer
Nontarget Present	.523	.742
Nontarget Absent	.805	.789
Mean	.664	.766

Figure 1. Mean proportion of responses correct for each nontarget size and block of nontarget positions in Experiment 1.